CLEAN

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NAVAL AIR STATION ALAMEDA, CALIFORNIA HYDROGEOLOGY AND PROPOSED CHANGES FOR PHASE 5 OF THE RI/FS

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1.0 INTRODUCTION

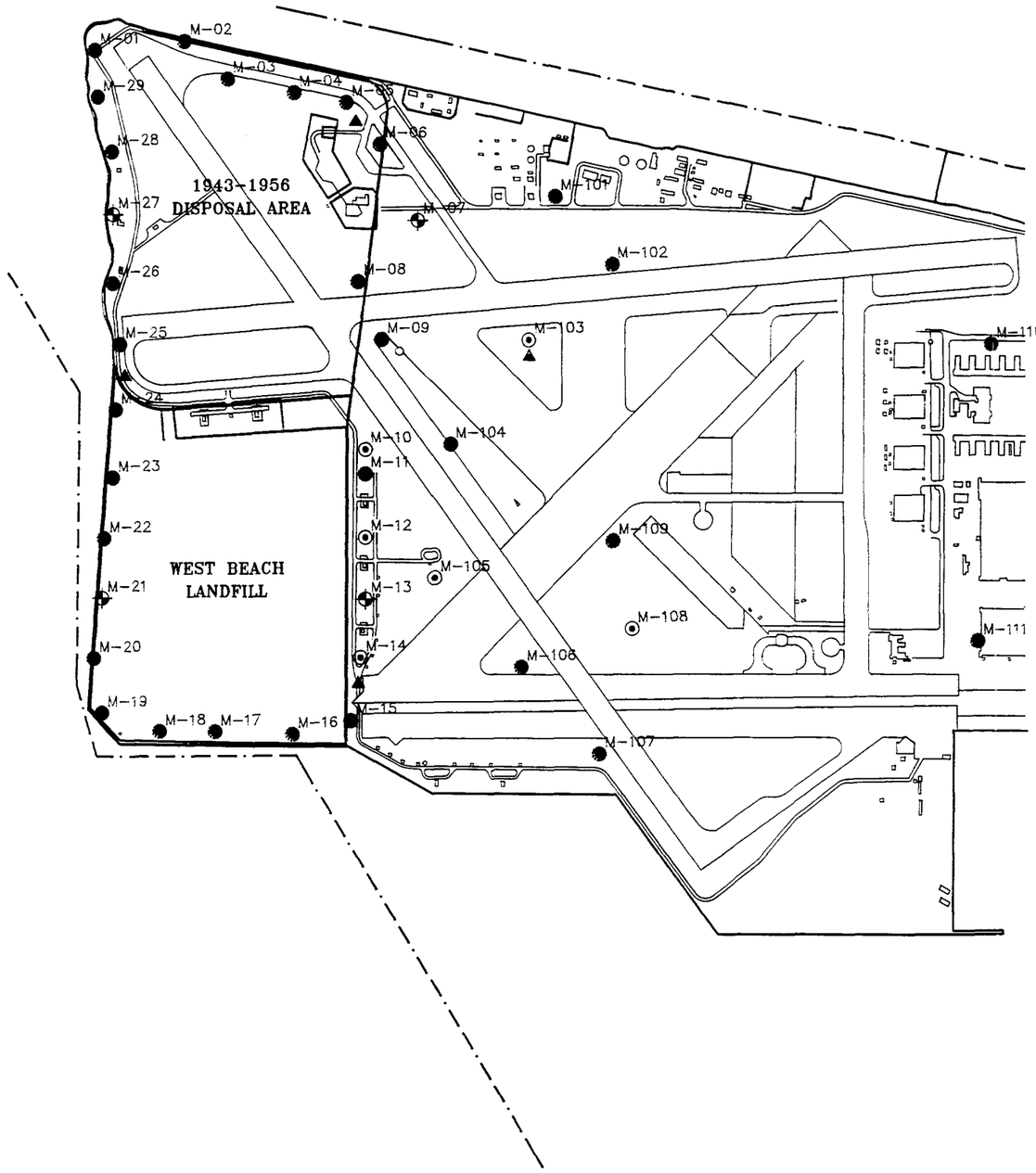
The Regional Water Quality Control Board requested the Navy to perform a Solid Waste Assessment Test (SWAT) for the 1943-1956 Disposal Area and the West Beach Landfill at Naval Air Station Alameda. The work plan for the SWAT was prepared by Canonie Environmental (Canonie) and approved by the Department of Health Services (DHS). The Navy implemented the work plan through Contract Task Orders (CTO) No. 0085 and No. 0107. These CTOs were awarded to PRC Environmental Management (PRC) and include the installation of 12 ground-water monitoring wells under CTO No. 0085 and 76 ground-water monitoring wells under CTO No. 0107 for a total of 88 wells (Figure 1). The installation of the wells was subcontracted to J. M. Montgomery (JMM). The 12 wells approved under CTO No. 0085 were installed in December 1990 and January 1991. Field work under CTO No. 0107 has not been initiated. The number and location of the wells was based on the hydrogeological conditions described in the work plan prepared by Canonie, dated February 1990.

In Volume 1A of the Canonie work plan, three stratigraphic layers underlying the 1943-1956 Disposal Area and the West Beach Landfill are described as being continuous throughout the area. The top layer is fill material that was artificially deposited in the landfills. This layer overlies the Bay mud which in turn overlies the Merritt Sand (Figure 2). The fill material was considered the "upper aquifer", the Merritt Sand was considered the "lower aquifer", and the Bay mud was considered an aquitard separating the two aquifers. The locations and construction of the 88 ground-water monitoring wells approved for the SWAT were based on Canonie's hydrogeologic interpretation.

While field work for the installation of the first 12 wells was in progress, a hydrogeological study of the area was conducted by PRC. The results of the study indicate that hydrogeological conditions below the landfills differ from what was described in the Canonie work plan. Due to these differences, it is believed that the existing ground-water monitoring program based on Canonie's approach is excessive. The objectives of this report are to present a revised interpretation of the hydrogeological conditions below the landfills and to propose changes to the ground-water monitoring program that was originally prepared.

2.0 HYDROGEOLOGY

The hydrogeological study conducted by PRC involved a literature search and analyses of boring logs. Boring logs from six deep exploratory borings drilled by Canonie in 1990 provided new information that was not included in previous studies. The geologic formations pertinent to



N

LEGEND

- ⊙ MONITORING WELLS INSTALLED DURING CTO 85: ONE WELL SCREENED WITHIN UPPERMOST WATER BEARING ZONE, ONE WELL SCREENED WITHIN THE SECOND WATER BEARING ZONE
- ● PROPOSED MONITORING WELL LOCATIONS FOR CTO 107, EACH LOCATION TO HAVE TWO WELLS: ONE WELL SCREENED WITHIN THE UPPERMOST WATER BEARING ZONE, ONE WELL SCREENED WITHIN THE SECOND WATER BEARING ZONE
- ⊕ PROPOSED MONITORING WELL LOCATIONS, EACH LOCATION TO HAVE THREE WELLS: ONE WELL SCREENED WITHIN THE UPPERMOST WATER BEARING ZONE, TWO WELLS SCREENED WITHIN THE UPPER AND LOWER PORTIONS OF THE SECOND WATER BEARING ZONE
- ▲ PROPOSED MONITORING WELL LOCATION, ONE WELL SCREENED THROUGHOUT THE SECOND WATER BEARING ZONE

0 587.5' 1175' 1762.5' 2350'

APPROXIMATE SCALE

FIGURE 1

PROPOSED MONITORING WELL LOCATIONS FOR SWAT (PHASES 5 & 6 OF RI/FS)

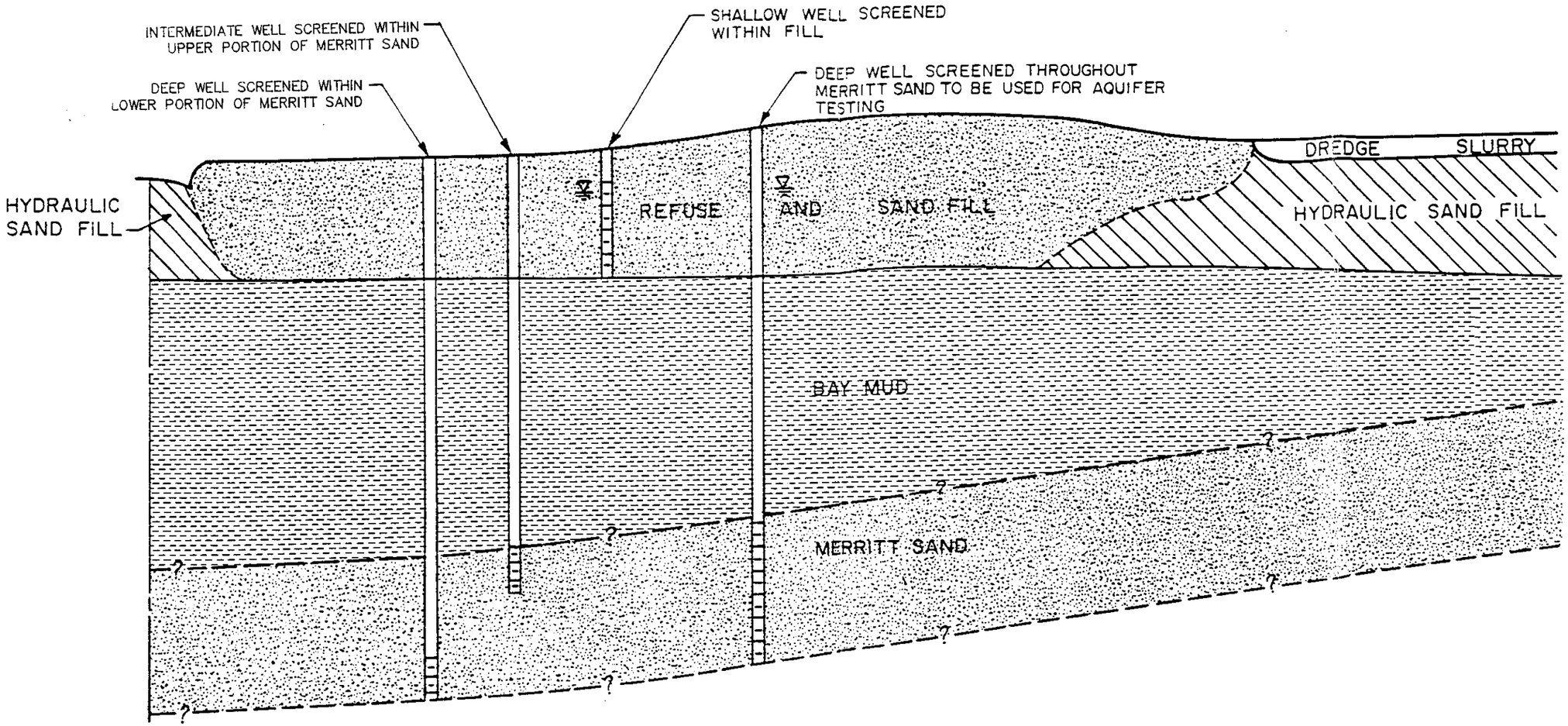


FIGURE 2

GENERALIZED MONITORING WELL CLUSTER NAVAL AIR STATION ALAMEDA, CALIFORNIA

MODIFIED FROM CANONIE ENVIRONMENTAL, DRAWING NO. 86-018-B32

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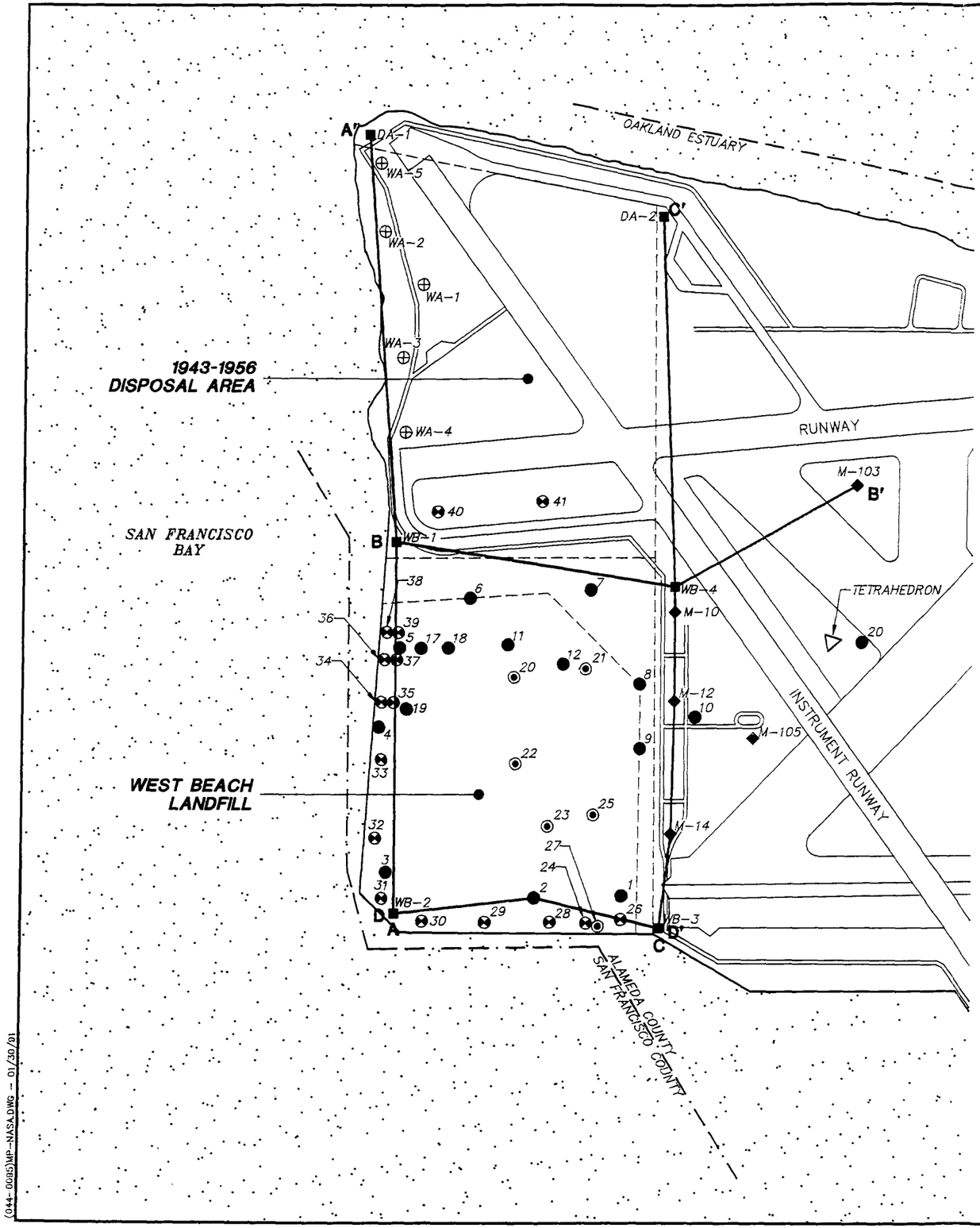
this study include, from oldest to youngest, the San Antonio formation, Posey formation, Merritt Sand, Bay mud, and artificially deposited fill material.

PRC's study shows a different stratigraphic sequence than what was presented in Canonie's work plan. Figures 3 through 7 illustrate PRC's interpretation of the stratigraphy. The Canonie work plan describes the Bay mud and the Merritt Sand as being continuous across the site. PRC's study shows that the Bay mud and the Merritt Sand are not continuous across the site. Similarly, a major portion of the study area is underlain by a thick sequence of silty and clayey sand within the Bay mud. This sand was not described in the Canonie work plan and is referred to as the Bay Mud sand in this report. Due to the discontinuous nature of the formations and the presence of permeable Bay Mud sand, all stratigraphic layers, including the fill material, are considered to be hydraulically connected. Consequently, the strata above the San Antonio formation are in the same aquifer system, not in two different aquifers as described in the Canonie work plan. PRC's interpretation is primarily based on correlations between the Canonie boring logs. The described native formations are often lithologically distinct and readily correlatable on the logs.

The deepest formation penetrated by borings drilled in the landfills is the San Antonio formation. The top of the San Antonio formation is approximately 100 feet below the land surface (Figures 4, 5, and 6). It is an overconsolidated, dark greenish-gray, silty clay. On boring logs it is described as being very stiff. The San Antonio is a member of the lower Bay mud and is considered an aquitard.

Overlying the San Antonio formation is the Posey formation (Figures 4 and 6). This stratum is approximately 6 feet thick and consists of a thin layer of gray, fine-grained sand which is often capped by a thin layer of clay. The Posey is actually a member of the lower Bay mud. However, the upper clay is not continuous, and distinguishing the Posey sands from the overlying Merritt Sand in boring logs may not always be possible. Because the overlying clay layer is discontinuous, the Posey formation is considered to be hydraulically connected to the overlying Merritt Sand. Therefore, for the purpose of analyzing hydrogeological conditions below the 1943-1956 Disposal Area and the West Beach Landfill, discussions pertaining to the Merritt Sand are also applicable to the Posey formation.

The Merritt Sand is an orange-brown, fine-grained sand. It was deposited in a nearshore environment as an eolian beach deposit. Cross sections through the landfills show that the Merritt Sand exists on the north and south sides of the study area, but not in the middle (Figures 3, 4, 5, 6, and 7). An erosional channel was formed through the Merritt Sand below the 1943-1956 Disposal Area and the West Beach Landfill after the sands were deposited. An isopach map of the Merritt Sand (Figure 8) shows that the channel runs east-west between the landfills. Bay Mud sand was deposited in the channel subsequent to erosion.



N

LEGEND

- ○ BORING DRILLED BEFORE 1970
- ● MONITORING WELL INSTALLED BY HARDING LAWSON, 1976, 1977
- ◉ MONITORING WELL INSTALLED BY HARDING LAWSON, 1983
- ⊕ MONITORING WELL INSTALLED BY WAHLER ASSOCIATES, 1985
- ⊗ MONITORING WELL, NO INFORMATION AVAILABLE
- ■ BORING DRILLED BY CANONIE, 1990
- ◆ MONITORING WELL INSTALLED BY J.M. MONTGOMERY, 1990
- **A-A'** GEOLOGIC CROSS SECTION

0 850' 1700' 2550' 3400'

APPROXIMATE SCALE

FIGURE 3

MONITORING WELL LOCATIONS
1943-1956 DISPOSAL AREA AND
WEST BEACH LANDFILL
NAVAL AIR STATION
ALAMEDA, CALIFORNIA

(044-0095)MP-NASA.DWG - 01/30/91

SOUTH
A

NORTH
A'

ELEVATION (MLLW)

120
100
80
60
40
20
0
-20

CANONIE WB-2

CANONIE WB-1

CANONIE DA-1

LAND SURFACE

LAND SURFACE

FILL

FILL

BAY MUD SAND

BAY MUD AQUITARD

MERRITT SAND

MERRITT SAND

BAY MUD SAND
WITH CLAY LENSES

POSEY FORMATION

POSEY FORMATION

? ? ?

SAN ANTONIO AQUITARD
(LOWER BAY MUD)

SAN ANTONIO AQUITARD
(LOWER BAY MUD)

LEGEND

- FILL
- SOFT CLAY
- STIFF CLAY
- GRAY SILTY OR CLAYEY SAND
- YELLOW-BROWN SAND

BORING ELEVATIONS ARE REFERENCED TO A NAVY DATUM POINT USING A MEAN LOWER LOW WATER (MLLW) DATUM

VERTICAL EXAGGERTATION: 20X

FIGURE 4

CROSS SECTION A - A'

(044-0095)CRO...-A.DWG - 02/06/00

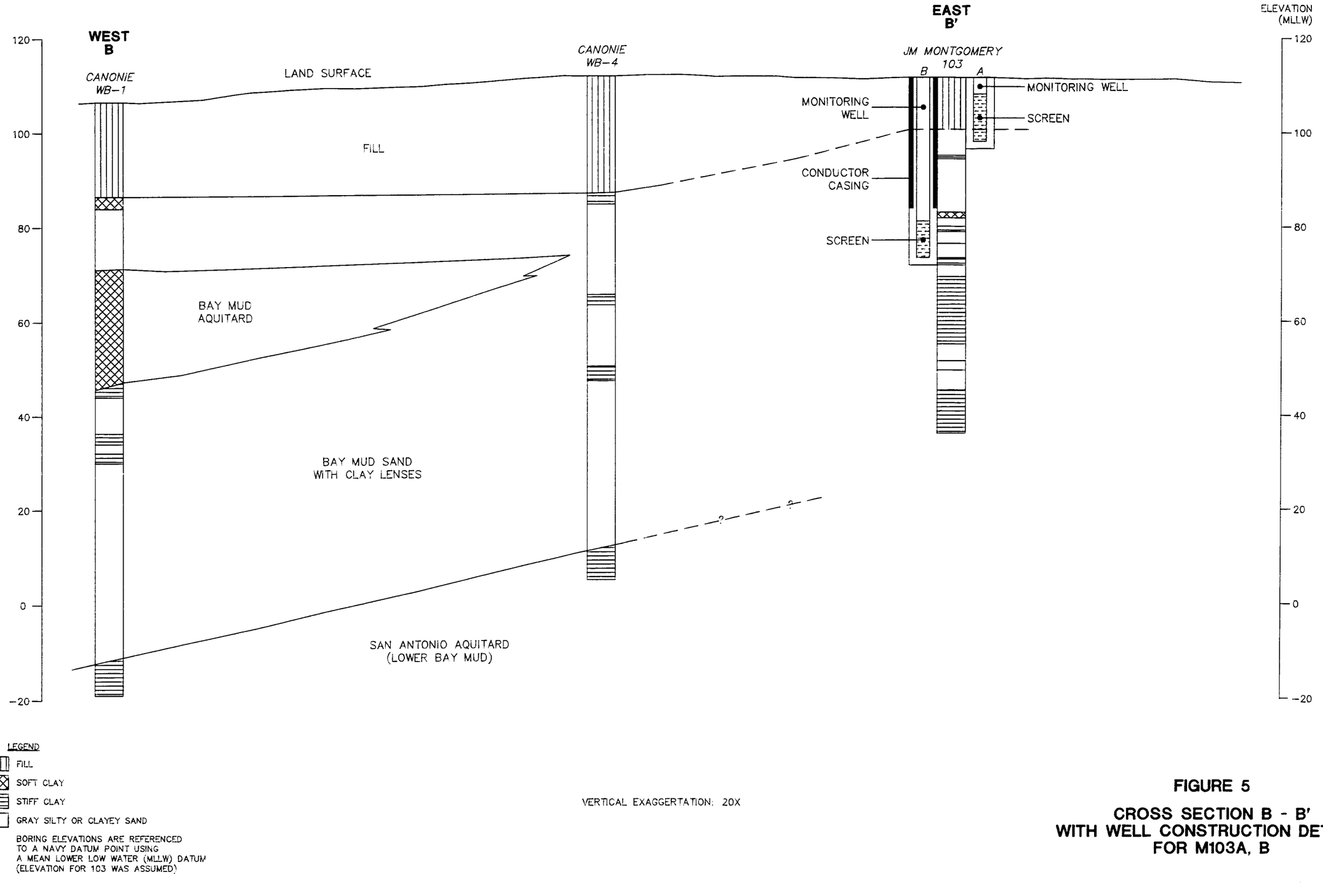
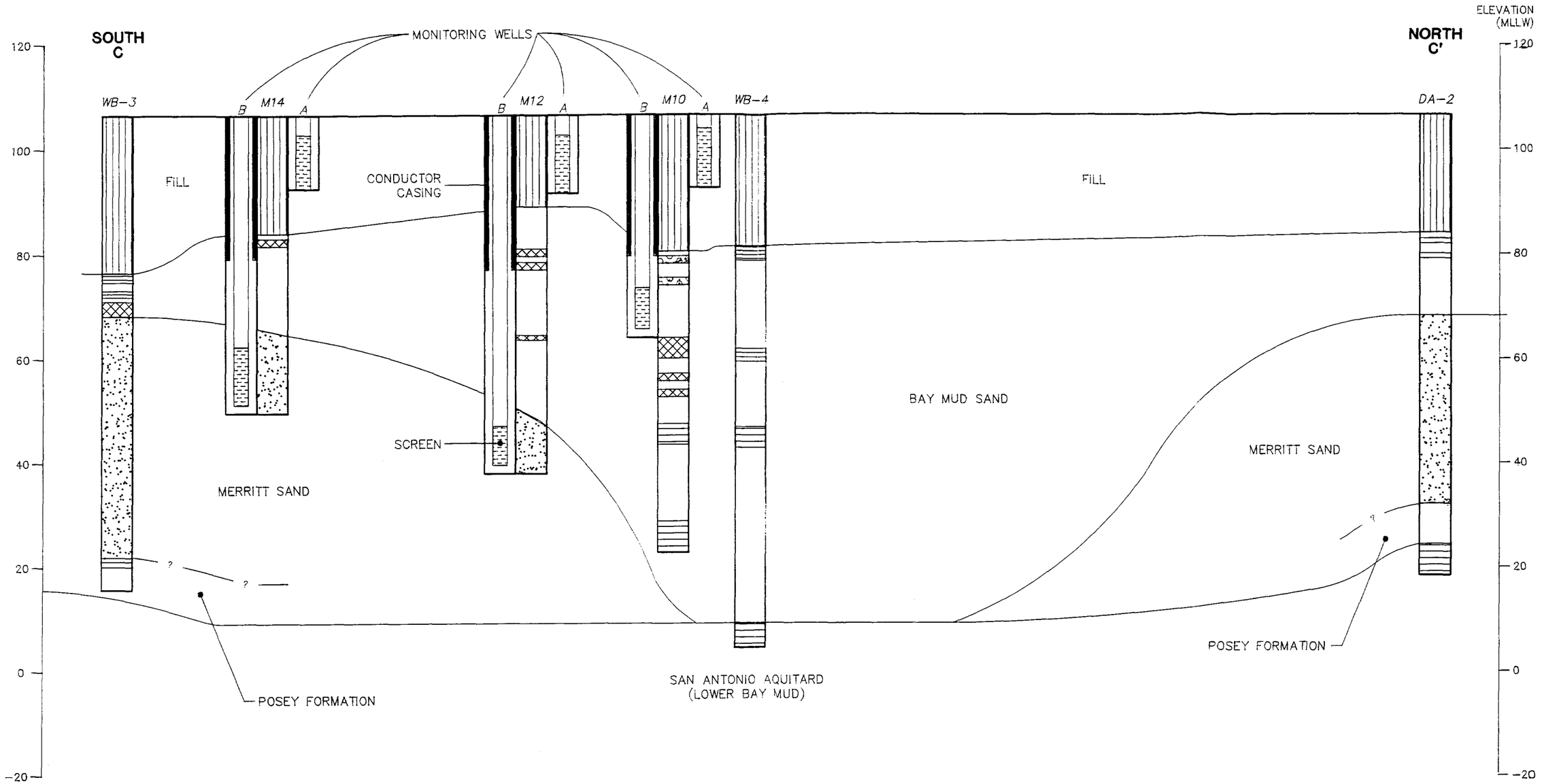


FIGURE 5

CROSS SECTION B - B'
WITH WELL CONSTRUCTION DETAILS
FOR M103A, B

(844-0085)CROSSB-B.DWG - 02/06/00



LEGEND

- FILL
- SOFT CLAY
- STIFF CLAY
- GRAY SILTY OR CLAYEY SAND
- YELLOW – BROWN SAND
- GRAVEL AND CLAY

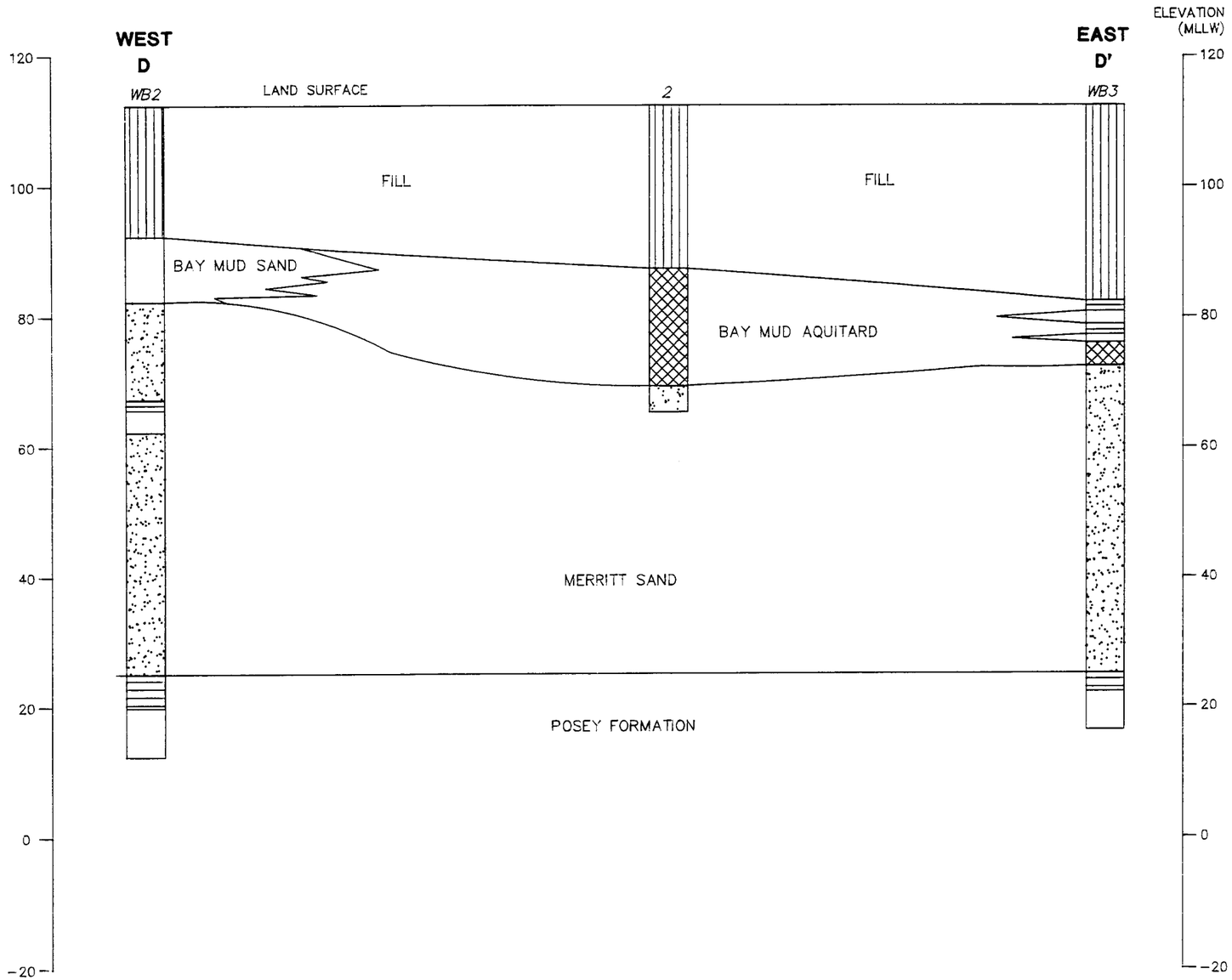
BORING ELEVATIONS ARE REFERENCED
TO A NAVY DATUM POINT USING
A MEAN LOWER LOW WATER (MLLW) DATUM
(ELEVATIONS FOR M14, M12, M10 ARE ASSUMED)

VERTICAL EXAGGERTATION: 20X

FIGURE 6

CROSS SECTION C - C'
WITH WELL CONSTRUCTION DETAILS
FOR M10A, B, M12A, B, AND M14A, B

(044-0000)CROSSC-C.DWG - 02/06/91



LEGEND

- FILL
- SOFT CLAY
- STIFF CLAY
- GRAY SILTY OR CLAYEY SAND
- YELLOW – BROWN SAND

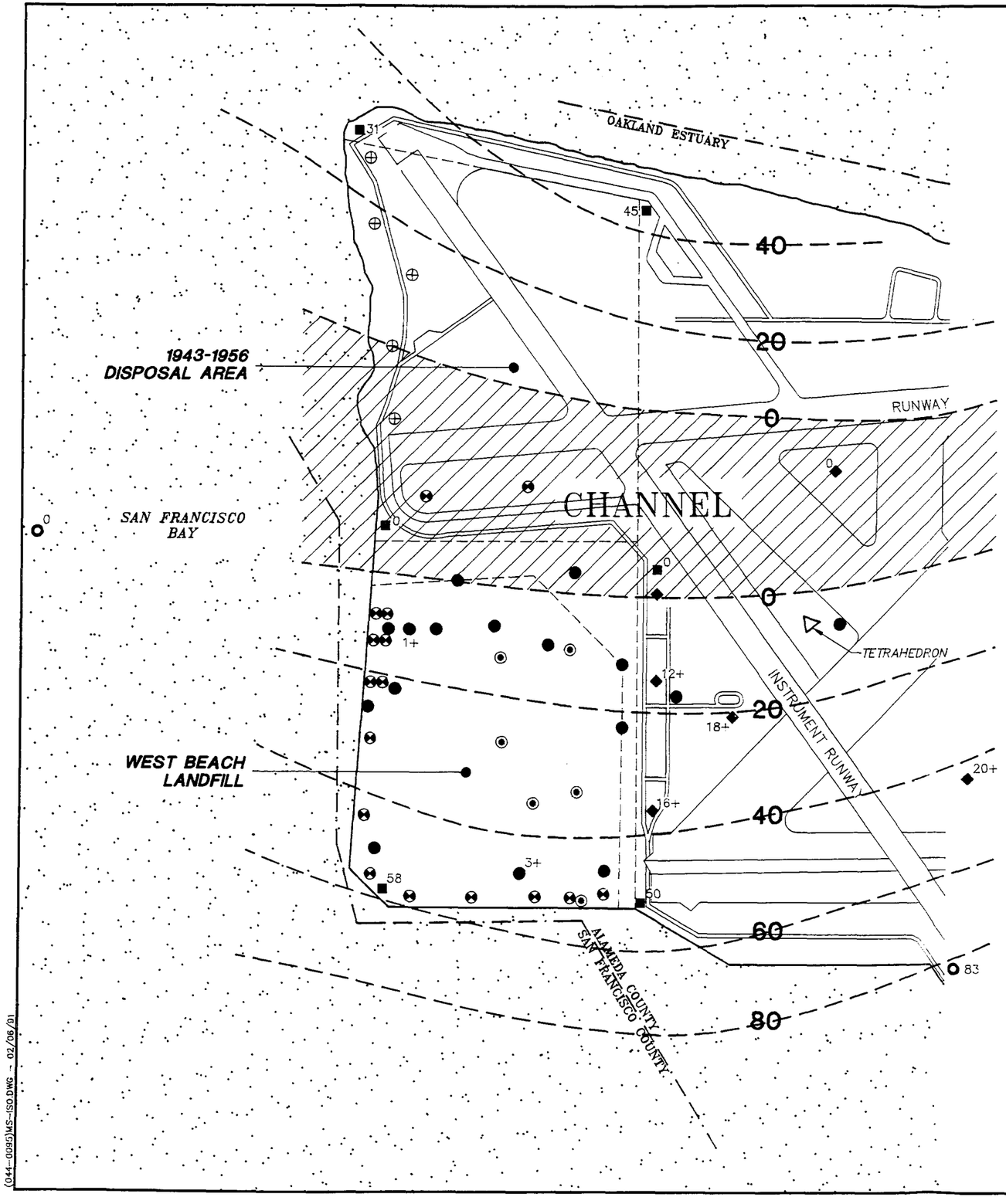
BORING ELEVATIONS ARE REFERENCED
TO A NAVY DATUM POINT USING
A MEAN LOWER LOW WATER (MLLW) DATUM
(ELEVATIONS FOR M14, M12, M10 ARE ASSUMED)

VERTICAL EXAGGERTATION: 25X

FIGURE 7

CROSS SECTION D - D'

(044-0095)CROSSD-D.DWG - 02/06/91



LEGEND

- BORING DRILLED BEFORE 1970
- MONITORING WELL INSTALLED BY HARDING LAWSON, 1976, 1977
- MONITORING WELL INSTALLED BY HARDING LAWSON, 1983
- MONITORING WELL INSTALLED BY WAHLER ASSOCIATES, 1985
- MONITORING WELL, NO INFORMATION AVAILABLE
- BORING DRILLED BY CANONIE, 1990
- MONITORING WELL INSTALLED BY J.M. MONTGOMERY, 1990
- 18+ THICKNESS SHOWN IS MINIMUM PENETRATED IN WELL. ACTUAL SAND THICKNESS IS GREATER

CONTOUR INTERVAL = 20 FEET

0 850' 1700' 2550' 3400'

APPROXIMATE SCALE

FIGURE 8

ISOPACH MAP OF MERRITT SAND NAVAL AIR STATION ALAMEDA, CALIFORNIA

(044-0095)MS-ISO.DWG - 02/06/91

The Bay Mud sand consists of gray, fine-grained, silty or clayey sand interbedded with stiff lenticular clay deposits (Figures 4, 5, 6 and 7). The clay layers are generally 1 to 5 feet thick. The stiffness of the clay results from aerial exposure and desiccation. The Bay Mud sand is unconsolidated and is believed to be relatively permeable.

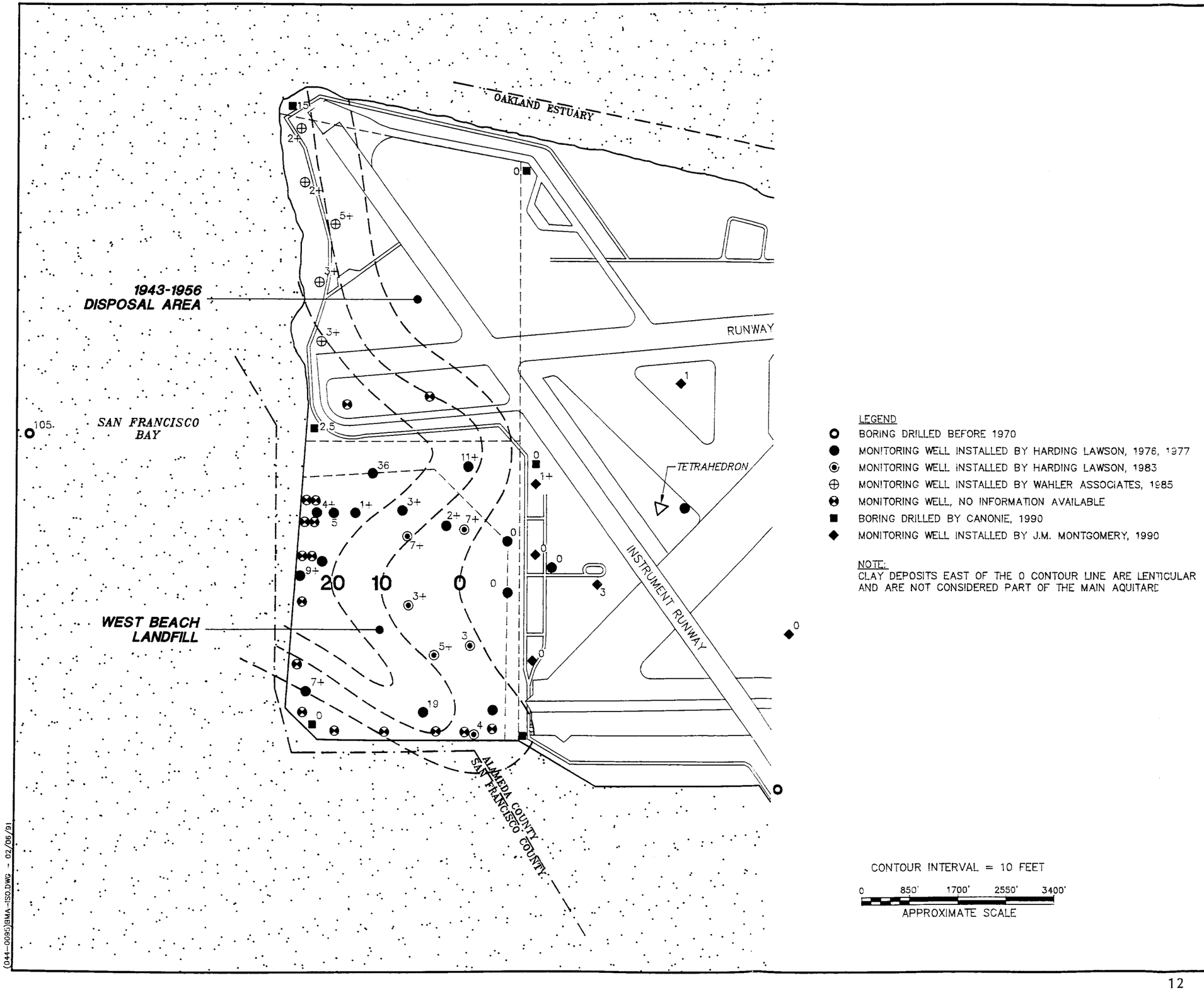
Above the Merritt Sand and the Bay Mud sand is a layer of soft clay deposited in a marine environment. The soft clay is referred to as the Bay Mud aquitard in this report (Figures 4, 5, and 7). The clay is as thick as 36 feet on the western side of the landfills, and pinches out under the landfills (Figure 9). The eastern boundary of the Bay Mud aquitard is based on boring logs prepared by Harding Lawson Associates, Canonie, and JMM. Boring logs not only show the aquitard thinning out to the east, but they also show lithologic changes in stratigraphically equivalent zones. The soft clay grades into a stiff clay in an easterly direction across the site. Finally, the stiff clay grades into silt or fine sand.

In the eastern portion of the site, east of the Bay Mud aquitard, clay members within the Bay Mud sand are most likely thin and lenticular. On most boring logs, the Merritt Sand is in direct contact with Bay Mud sand. This contradicts the interpretation presented by Canonie. The Bay Mud aquitard separates the overlying fill material from native sands only on the west side of the landfills, but it does not separate an "upper aquifer" from a "lower aquifer." The fill material and the native sands are hydraulically connected due to the absence of the Bay Mud aquitard on the east side of the landfills.

3.0 WATER LEVELS IN MONITORING WELLS

The 12 ground-water monitoring wells installed during December 1990 and January 1991 are located in six two-well clusters (locations M-10, M-12, M-14, M-103, M-105, and M-108 on Figure 1). The first well is screened in the landfill material and the second well is screened in the native sands below the landfill. Well construction details are illustrated on Figures 5, 6, and 10. The purpose of these wells is to monitor ground-water contamination in the landfill and in the Merritt Sand as defined by Canonie.

The first round of water level measurements was recorded on February 5, 1991. Water table elevations are presented in Table 1. The difference in water levels between the shallow well and the deep well at each location varied from 0.16 feet to 1.86 feet. In all cases, water level



LEGEND

- BORING DRILLED BEFORE 1970
- MONITORING WELL INSTALLED BY HARDING LAWSON, 1976, 1977
- MONITORING WELL INSTALLED BY HARDING LAWSON, 1983
- MONITORING WELL INSTALLED BY WAHLER ASSOCIATES, 1985
- MONITORING WELL, NO INFORMATION AVAILABLE
- BORING DRILLED BY CANONIE, 1990
- MONITORING WELL INSTALLED BY J.M. MONTGOMERY, 1990

NOTE:
CLAY DEPOSITS EAST OF THE 0 CONTOUR LINE ARE LENTICULAR AND ARE NOT CONSIDERED PART OF THE MAIN AQUITARD

CONTOUR INTERVAL = 10 FEET

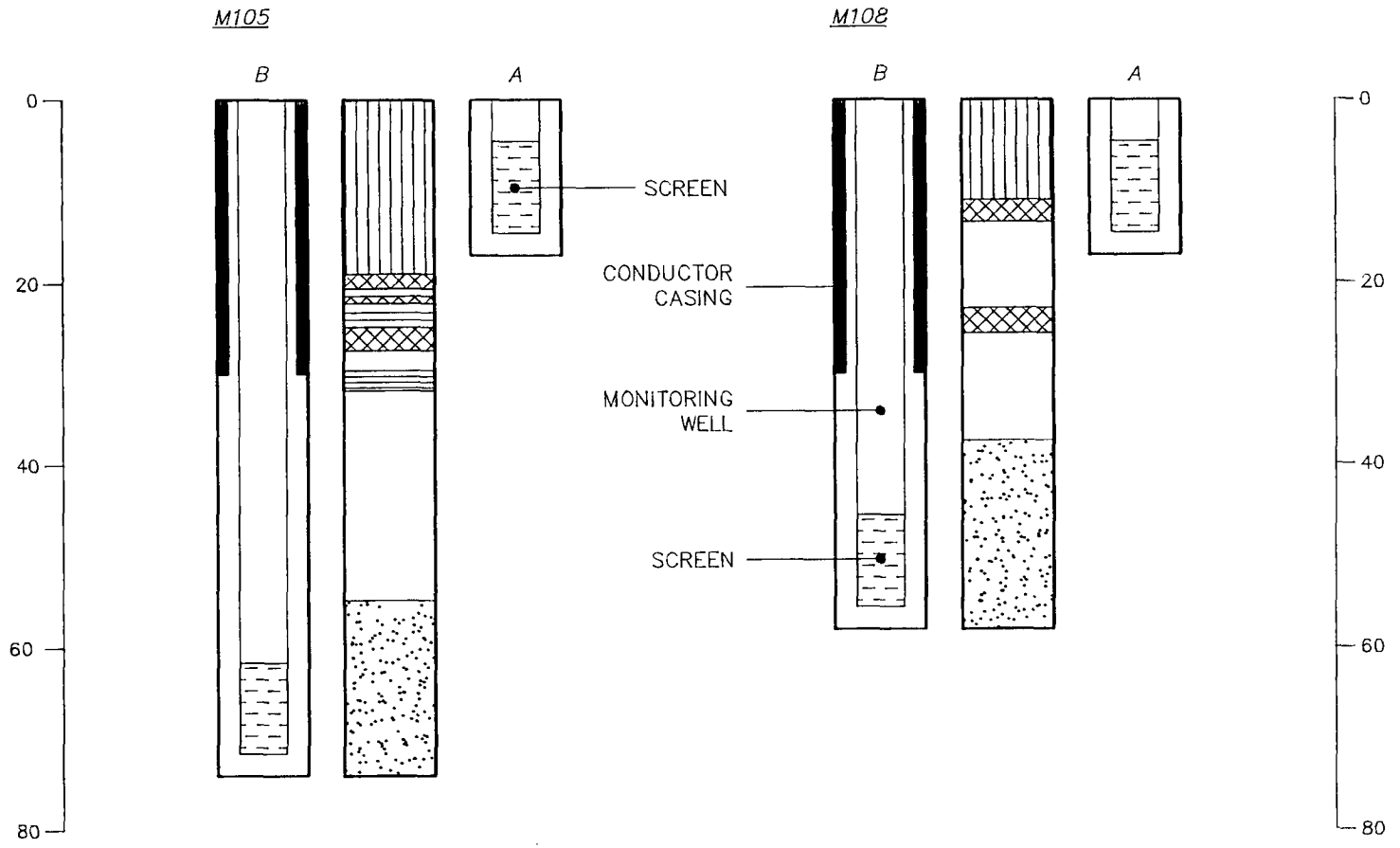
0 850' 1700' 2550' 3400'

APPROXIMATE SCALE

FIGURE 9

ISOPACH MAP OF BAY MUD AQUITARD NAVAL AIR STATION ALAMEDA, CALIFORNIA

(044-0095)BMA-ISO.DWG - 02/06/91



LEGEND

- FILL
- SOFT CLAY/CLAYEY SILT
- SILTY OR CLAYEY SAND/SAND
- MERRITT SAND

FIGURE 10

WELL CONSTRUCTION DETAILS FOR M105A, B, AND M108A, B

TABLE 1

STATIC WATER TABLE ELEVATIONS IN MONITORING WELLS

Monitoring Well	February 5, 1991 Elevation above sea level	Difference	February 20, 1991 Elevation above sea level	Difference	Difference Between Dates
M-10A	3.49		3.24		Fall 0.25
M-10B	3.33	-0.16	3.36	+0.12	Rise 0.03
M-12A	3.58		3.90		Rise 0.32
M-12B	3.27	-0.31	3.37	-0.53	Rise 0.10
M-14A	4.30		3.55		Fall 0.75
M-14B	2.71	-1.59	2.62	-0.93	Fall 0.09
M-103A	6.85		6.04		Fall 0.81
M-103B	5.28	-1.57	5.44	-0.60	Rise 0.16
M-105A	4.94		5.36		Rise 0.42
M-105Br	3.76	-1.18	3.86	-1.50	Rise 0.10
M-108A	5.96		5.77		Fall 0.19
M-108B	4.10	-1.86	4.02	-1.75	Fall 0.08

Notes:

Water level information collected from ground-water monitoring wells installed at NAS Alameda during December 1990 and January 1991.

elevations were higher in the shallow wells. Immediately prior to the February 5 measurements, significant rainfall occurred (estimate 2 inches or more). At NAS Alameda, rainfall may tend to affect water levels in shallow wells sooner than in deeper wells and accounts for the higher water levels in the shallow wells.

A second round of water levels was obtained on February 20, 1991. Review of the water level measurements taken on February 5 and 20 shows no consistent pattern of water level changes. Water levels recorded on February 20 from two of the shallow wells were higher in elevation than those measured on February 5. The water levels in the other four shallow wells dropped from 0.19 feet to 0.81 feet. The water level measurements recorded on February 20 from the deep wells varied from 0.09 feet lower to 0.16 feet higher than those recorded on February 5.

Factors other than rainfall may also influence water table elevations at NAS Alameda. These include changes in salinity (affects water density), hydraulic conductivity near the screen intake (affects recharge rates), and tidal influence. Tidal changes may also affect water levels in deeper wells differently than water levels in shallow wells. Until a tidal influence study is conducted, preferably after the effects of rainfall have passed, water level elevation changes in monitoring wells may not be completely understood. However, preliminary water level data collected so far is not conclusive as to the existence of different aquifers, considering other factors such as salinity, recharge parameters and tidal influence.

4.0 DISCUSSION OF CONTAMINANT TRANSPORT

The principal modes of contaminant transport in ground water are advection and hydrodynamic dispersion. Advection is movement due to physical forces such as hydraulic pressure gradients. Hydrodynamic dispersion is movement due to molecular forces such as concentration gradients. Additionally, vertical transport of contaminants within an aquifer is affected by the density of the contaminant. Low density contaminants will tend to migrate to the top of the water table, high density contaminants will tend to migrate down with gravity, and contaminants with a density approximately equal to water will tend to disperse throughout the aquifer. While the various transport mechanisms are in process, retardation is also occurring. Retardation slows the transport of contaminants.

A properly designed ground-water monitoring program should consider the transport mechanisms and the direction of ground-water flow. Contaminants in the 1943-1956 Disposal Area and West Beach Landfill have been in transport anywhere from 13 to 48 years. Dispersion of the contaminants during this interval has probably been extensive. Additionally, water level

measurements recorded from ground-water monitoring wells installed during December 1990 and January 1991 indicate that ground water flows in a westerly direction. The location of monitoring wells at the landfills and the screened intervals should be based on this information and chosen so that the extent of ground-water contamination can be identified.

4.1 Shallow Ground-Water Monitoring

A significant number of contaminants at the 1943-1956 Disposal Area and the West Beach Landfill have densities lower than water. These contaminants can be detected with shallow monitoring wells which are screened above the water table. Contaminants with a density approximately equal to water can also be detected in the shallow wells. Because contaminant plumes may finger due to heterogeneities in soil, several ground-water monitoring wells are usually installed at a site. Due to the large area at the 1943-1956 Disposal area and the West Beach landfill, the installation of 40 shallow ground-water monitoring wells is justified.

4.2 Intermediate Depth Ground-Water Monitoring

Forty monitoring wells have also been approved for monitoring ground water in the upper Merritt Sand. Based on PRC's interpretation of the hydrogeology, the upper Merritt Sand is in the middle of the aquifer. Contaminants that may be detected in ground-water samples collected from these intermediate-depth wells include the following:

1) High-density contaminants that adsorb and desorb from organic debris and fine grained soil

2) High-density contaminants in the process of migrating downward

3) Contaminants with a density approximately equal to water and migrating due to hydrodynamic dispersion

Ground-water analytical data collected from the intermediate wells proposed for installation on the south, east, and north sides of the landfills may not contribute significantly to defining the extent of ground-water contamination. These locations may be near or beyond the edge of the Bay Mud aquitard. High-density contaminants from sources on the south, east, and north sides of the landfill may migrate to the Merritt Sand and the Bay Mud sand because no aquitard exists, but they may not necessarily stay near the top of the aquifer due to their high density. As the contaminants migrate in a westerly direction with ground-water flow, they will tend to migrate down with gravity. The deep monitoring wells should detect these contaminants. Contaminants with a density approximately equal to water may be present at the intermediate depths, but they should also be present in the shallow and deep wells. In summary, there appears

to be no purpose for installing the intermediate-depth wells on the south, east, and north sides of the landfill at this time.

Intermediate-depth ground-water monitoring wells installed on the west side of the landfills may provide significant data for evaluating ground-water contamination. High-density contaminants from sources on the west side of the landfills may most likely move west through the landfill due to advection or hydrodynamic dispersion, but they may not move vertically to the Merritt Sand or Bay Mud sand due to the presence of the Bay Mud aquitard. Additionally, these contaminants may not be transported to the east side of the landfill where they may migrate vertically because ground water flows from east to west. Consequently, the ground-water chemistry in the western portion of the landfills may be different than the ground-water chemistry in the sands below the Bay Mud aquitard. Therefore, the installation of some intermediate wells on the west side of the landfills is justified to determine the differences in ground-water chemistry.

The vertical migration of high-density contaminants on the west side of the landfills may be inhibited due to the presence of the Bay Mud aquitard. Additional ground-water monitoring wells should be installed to monitor these contaminants. These monitoring wells should be screened from the top of the Bay Mud aquitard to ten feet above the top of the Bay Mud aquitard. This interval includes naturally deposited Bay Mud sand underlying landfill material. The monitoring wells should be installed only where the Bay Mud aquitard exists.

It is believed that the installation of intermediate-depth ground-water monitoring wells on the south, east, and north side of the landfills is not technically justified at this time. However, intermediate depth wells installed on the west side may yield important information concerning differences in ground-water chemistry. Twelve intermediate-depth wells have been approved for installation on the west side of the landfills. However, it is believed that four wells will be adequate at this time.

4.3 Deep Ground-Water Monitoring

Four deep wells, screened in the lower portion of the Merritt Sand, have been proposed for installation to evaluate the presence of contaminants with a density higher than water. These wells will be located on the flanks of the channel eroded through the Merritt Sand and should yield information critical to evaluating the extent of contamination. However, high-density contaminants may ultimately migrate to the deeper portions of the aquifer. Two additional deep wells installed in the deep portions of the channel may be necessary to evaluate the presence of high density contaminants. Therefore, it is recommended that two additional deep wells be

installed in the deep portions of the channel. One well should be installed upgradient of the landfill and one well should be installed downgradient.

5.0 PROPOSED CHANGES TO WORK PLAN

The installation of 88 ground-water monitoring wells was approved for the SWAT at the West Beach Landfill and the 1943-1956 Disposal Area (Table 2). The installation of conductor casing through landfill material in the intermediate, deep, and fully penetrating wells was also approved. During December 1990 and January 1991, six shallow wells and six intermediate wells were installed. Therefore, 34 shallow wells, 34 intermediate wells, and all of the eight deep wells are approved for installation during future activities. Recommended changes to this ground-water monitoring well program are presented below.

5.1 Monitoring Wells

The rationale for installing the intermediate wells was given in Canonie's Solid Waste Assessment Test (SWAT), Proposal Addendum, dated February 1990. According to the report "the Bay mud should act as an aquitard between the uppermost water bearing zone and the second water bearing zone. This second deeper well will provide a means of sampling the second water bearing zone separately, because of the sealing of the upper water bearing zone." The uppermost water bearing zone refers to landfill material and the second water bearing zone refers to the Merritt Sand. As discussed in previous sections of this report, these water bearing zones, or aquifers, are considered to be hydraulically connected on the east side of the landfills. The installation of four intermediate wells on the west side of the landfills is appropriate. However, the installation of intermediate wells on the south, east, and north side of the landfills is not technically justified. Six intermediate wells, out of the original 40 intermediate wells approved for the project, have been installed. The remaining 34 wells have been approved for installation in the future. It is proposed that 30 of these wells be eliminated from the program. The 4 remaining intermediate wells should be installed at locations M-01, M-27, M-20, and M-22 (Figure 1).

The presence of high-density contaminants on top of the Bay Mud aquitard was not previously addressed. The installation of ground-water monitoring wells, screened from the top of the Bay mud to 10 feet above the top of the Bay Mud aquitard, should identify the presence of these contaminants. These wells should be installed on the west side of the landfills where the Bay Mud aquitard is present. Therefore, it is recommended that additional ground-water monitoring wells, screened above the Bay Mud aquitard, be installed at locations M-01, M-02, and M-18 through M-29 (Figure 1) for a total of 14 wells.

TABLE 2

MONITORING WELLS APPROVED FOR THE SWAT AT THE WEST BEACH LANDFILL AND THE 1943-1956 DISPOSAL AREA

Well Description	Screened Interval	Number of Wells
Shallow wells	Upper landfill material	40
Intermediate Well	Top of Merritt Sand	40
Deep Well	Bottom of Merritt Sand	4
Fully Penetrating Deep Well	Full depth of Merritt Sand	4

The purpose of installing conductor casing is to prevent cross contamination between an upper aquifer and a lower aquifer during the installation of a monitoring well. The fill material and the Merritt Sand at the 1943-1956 Disposal Area and the West Beach landfill are considered to be in the same aquifer system. Therefore, it is proposed that the installation of conductor casing in the deep wells on the east side of the landfills be eliminated. However, it is recommended that conductor casing be installed in the intermediate and deep wells on the west side of the landfills. At these locations, the type of contamination present in the fill material may be different than in the Merritt Sand or the Bay Mud sand. Conductor casing installed in the three deep wells and the four intermediate wells on the west side of the landfill should prevent cross-contamination.

The original scope of work included the installation of four deep wells screened in the lower portion of the Merritt Sand. The purpose of the deep wells is to investigate the extent of contaminants with a density similar to or higher than water. These contaminants may most likely migrate to the bottom of the aquifer, which in this case is the bottom of the channel eroded through the Merritt Sand. The four deep wells that have been proposed are located on the flanks of the channel. It is therefore proposed that two additional deep wells be installed at locations M-25 and M-104 to evaluate high density contaminants in the bottom of the channel. The deepest portion of the aquifer is probably near location M-25. This location is also on the downgradient side of the landfill. If high-density contaminants have extensively dispersed throughout the aquifer, they should be present near this location. Location M-104 is upgradient of the landfill. Ground-water data collected from this location may provide a means of evaluating background concentrations at the bottom of the aquifer.

The proposed reduction in the number of monitoring wells to be installed will reduce the collection of data. However, it is believed that the data collected will yield the information necessary to understand the nature and extent of ground-water contamination at the 1943-1956 Disposal Area and the West Beach Landfill. A phased approach to all projects of this magnitude is recommended. Additional monitoring wells can always be installed in the future if more data is necessary to evaluate ground-water contamination.

5.2 Aquifer Tests

Four aquifer tests have been approved for the remedial investigation. The four fully penetrating deep wells listed in Table 2 were approved for these aquifer tests. The purpose of the aquifer tests is to determine aquifer properties (hydraulic conductivities and storage coefficient) and to evaluate hydrogeologic conditions below the landfills. This information will

be critical for modeling ground-water flow and contaminant transport. Aquifer properties will also be required for the feasibility study and remedial design.

Based on the hydrogeologic interpretation presented in this report, it is recommended that the aquifer testing program be refined so that data collected during the tests will be more useful in understanding the hydrogeological conditions in the area. It is proposed that two aquifer tests be performed. Although the proposed number of tests has been reduced by half from the original scope of work, the proposed tests will be more involved than originally planned. The tests are described below.

1) The purpose of the first test is to evaluate the hydraulic conductivity and storage coefficient of the Bay Mud sand below the Bay Mud aquitard. Additionally, vertical transport through the Bay Mud aquitard can be addressed, as well as hydraulic communication between the Bay Mud sand and the landfill material.

   Location of Pumping Well: 60 feet south of M-25

   Pumping Well Construction: It is proposed that a 6-inch diameter well installed to the top of the San Antonio formation be used as the pumping well. The well will be screened for the entire thickness of the Bay Mud sand, from the bottom of the Bay Mud aquitard to the top of the San Antonio formation.

   Location of Observation Wells:

   T1A) Shallow well at M-25
   T1B) Intermediate well at M-25, screened at middepth in Bay Mud aquitard
   T1C) Deep well at M-25, screened at middepth of Bay Mud sand
   T1D) Shallow well 100 feet north of M-25, screened at middepth of landfill material
   T1E) Intermediate well 100 feet north of M-25, screened at middepth of Bay Mud aquitard
   T1F) Deep well 100 feet north of M-25, screened at middepth of Bay Mud sand

   Observation Well Construction: It is proposed that observation wells screened in formations deeper than the fill material (Bay Mud aquitard, natural sands below Bay Mud aquitard) be constructed with 2-inch diameter PVC pipe. A conductor casing should be installed to the top of the Bay Mud aquitard to prevent cross contamination between ground water in the landfill and ground water in the screened interval. It is proposed that 2-inch diameter well points be used for temporary shallow observation

wells where no ground water samples will be collected. Observation well T1D should be constructed with this method.

Comments: The arrangement of observation wells listed above is ideal for an aquifer test. However, wells T1B, T1C, T1D, T1E and T1F are not included in the ground-water monitoring well program and will have to be installed separately. To reduce costs, the deep well proposed at M-25 for the collection of ground-water samples may be used as observation well T1C. Wells T1B, T1D, T1E, and T1F will still have to be installed for the purpose of this test. The construction of T1E should be the same as T1C. Other ground-water monitoring wells that will be installed for the purpose of collecting ground-water samples are most likely too far away (500 feet) to be useful for the aquifer test.

2) The purpose of the second test is to evaluate the hydraulic conductivity and storage coefficient of the Merritt Sand. This location was chosen because the Merritt Sand is thickest in this area and the Bay Mud sand is thin. The hydraulic conductivity obtained from the test may be more representative of the Merritt Sand. Aquifer properties for the Merritt Sand are critical for understanding ground-water flow because a large portion of the soil underlying the landfills consists of the Merritt Sand.

Location of Pumping Well: Northwest of M-107:

Pumping Well Construction: It is proposed that a 6-inch diameter well installed to the top of the San Antonio formation be used as the pumping well. The well will be screened for the entire thickness of the Merritt Sand.

Location of Observation Wells:

T2A) 60 feet east of pumping well, screened at midpoint of Merritt Sand
T2B) 60 feet east of pumping well, screened at midpoint of Bay Mud sand
T2C) 150 feet east of pumping well, screened at midpoint of Merritt Sand
T2D) 150 feet east of pumping well, screened at midpoint of Bay Mud sand

Observation Well Construction: All of the proposed observation wells are temporary wells where no ground-water samples will be collected. It is proposed that all observation wells be constructed with 2-inch diameter well points.

After the observation wells are installed for both tests, water level measurements should be monitored at least one day before the aquifer tests begin. Ideally, these measurements should be included in the tidal influence study. A multichannel data logger with dedicated pressure transducers can be used for this purpose. In order to reduce the effects of barometric pressure changes on water level measurements, the transducers should be vented. The aquifer test should begin after the tidal influence test has been completed and with all equipment left in place.

Conducting an aquifer test in the landfill material is not recommended for the following reasons:

1) Large amounts of contaminated water may be pumped out of the landfill. This could cause a health and safety problem as well as a disposal problem.

2) The pumping well may have to be located at the edge of the landfill where hydrogeologic conditions change. The data collected may not be representative of the landfill material.

3) Slug tests will be conducted in all of the shallow ground-water monitoring wells. These wells are screened in the fill material and completely encircle the landfill. Hydraulic conductivities evaluated from the slug tests may provide adequate data for evaluating ground-water flow.

The aquifer testing program presented above is intended to be an outline and is not intended to be a work plan. Rationale for the recommendations were based on the hydrogeological interpretation in this report. A work plan for the aquifer testing program and tidal influence study will be prepared after completion of the tasks which involve well installation and geophysical surveys. Data collected from these tasks may aid in the preparation of the work plan.

5.3 Geophysical Surveys

Two geophysical surveys for the 1943-1956 Disposal Area and the West Beach Landfill have been approved. These surveys are electromagnetics and magnetometry. They are adequate for defining the location of metallic objects in the landfill, but they are not appropriate for interpreting the subsurface geology. In order to define the channel below the 1943-1956 Disposal Area and the West Beach Landfill, it is recommended that an additional geophysical survey be conducted. The specific technique to be used will be provided by a subcontractor.

6.0 SUMMARY AND CONCLUSION

The recommendations in this report are based on the interpretation of new data. It is believed that these recommendations may eliminate excessive expenditures for the project, but may not reduce the ability to evaluate ground-water contamination or hydrogeologic conditions at the 1943-1956 Disposal Area and the West Beach Landfill. In summary, the results of this hydrogeological study indicate that the landfill material at the 1943-1956 Disposal Area and the West Beach Landfill and the Merritt Sand are in the same aquifer system. It is recommended that the scope of work for the original work plan be changed as follows:

1) Thirty intermediate wells screened in the upper portion of the Merritt Sand be eliminated from the scope of work.

2) Two additional deep wells screened in the lower portion of the Merritt Sand be installed in the channel.

3) Fourteen additional shallow monitoring wells screened above the Bay Mud aquitard be installed on the west side of the landfills.

4) The installation of conductor casing in deep wells on the east side of the landfills be eliminated.

5) Two aquifer tests be conducted and a tidal influence study be added to the aquifer test program.

6) Eight observation wells be installed for the aquifer tests.

7) An additional geophysical survey be conducted to better define the channel below the 1943-1956 Disposal Area and the West Beach Landfill.

Table 3 summarizes the recommended changes to the original work plan. As new data becomes available, the interpretation of the hydrogeological conditions at the 1943-1956 Disposal Area and the West Beach Landfill may be refined further. Consequently, it is expected that additional changes in the scope of work may be recommended in the future.

TABLE 3

RECOMMENDED CHANGES TO THE GROUND-WATER MONITORING WELL PROGRAM FOR THE SWAT AT THE WEST BEACH LANDFILL AND THE 1943-1956 DISPOSAL AREA

Well Description	Screened Interval	Proposed No. of Wells	No. of Wells Previously Installed	Recommended No. of Wells to be Installed in Future
Shallow Wells	Upper landfill material	40	6	34
Shallow Wells	Lower landfill material	0	0	14
Intermediate Well	Top of Merritt Sand	40	6	4
Deep Well	Bottom of Merritt Sand	4	0	6
Fully Penetrating Deep Well For Aquifer Test	Full Depth of Merritt Sand	4	0	2
Observation Wells For Aquifer Tests	Landfill Material	0	0	1
	Bay Mud Sand	0	0	2
	Bay Mud Aquitard	0	0	3
	Merritt Sand	0	0	2
Total Monitoring Wells		88	12	60
Total Observation Wells		0	0	8

APPENDIX A
DEPARTMENT OF HEALTH SERVICES (DHS) COMMENTS AND NAVY RESPONSE

APPENDIX A

NAVY RESPONSE TO DHS COMMENTS DRAFT HYDROLOGY AND PROPOSED CHANGES FOR PHASE 5 OF THE RI/FS - NAS ALAMEDA

GENERAL COMMENTS

Explain why geophysical techniques were not proposed to better define the channel boundaries. The channel would be a preferential pathway for contaminant migration.

The report implies that a tidal influence study is necessary to fully characterize the ground water. The Department concurs and recommends that the Navy prepare a tidal influence study work plan and aquifer testing work plan (see comment on Section 5.2) for submittal to the regulatory agencies.

Response: Section 5.3 which describes geophysical surveys has been added to this report. This section was previously omitted because J.M. Montgomery is currently in the process of evaluating the proper geophysical technique to use that will define the channel underlying the 1943-1956 Disposal Area and the West Beach Landfill. The geophysical techniques approved in the CTO No. 0107 work plan are not appropriate for defining the subsurface geology and a new technique must be selected. Using a geophysical technique to interpret the subsurface geology was also discussed between the Navy, PRC, and the DHS during a meeting on February 11, 1991. It is suspected that seismic reflection or seismic refraction will be used. However, at this time, a specific geophysical technique has not been recommended.

A tidal influence study work plan and aquifer testing work plan will be prepared after the ground-water monitoring wells have been installed and the geophysical surveys have been conducted and interpreted. Information collected from the completion of these tasks may aid in the preparation of the work plan.

SPECIFIC COMMENTS

Comment No. 1. Section 4.3, Page 17 - The section does not specifically state that the two additional deep wells in the channel would be installed. The Department believes that the two deep wells should be installed.

Response: The installation of two additional deep wells at locations M-25 and M-104 was recommended in Section 5.1, page 18, paragraph 3 of the draft document. Also, these recommendations were added in Section 4.3, page 17, paragraph 1, of this report.

Comment No. 2. Section 5.1, Page 18 - The Department concurs with the technical justification for not placing intermediate wells in the east, south or north areas of the landfills. It would appear that the Bay Mud Aquitard does extend from approximately the middle of the landfills westward. However, the western portion of the Bay Mud Aquitard would hinder the downward migration of the "sinkers" from the western portion of the landfills. The Department recommends that monitor wells be installed along the western side (Figure 1 locations; M-01, M-02, M-18 through M-29) of the landfills to monitor for contaminants at the Bay Mud Sand/Bay Mud Aquitard interface.

Line 9. Reference Figure 1.

Response: The recommendation to install 14 additional ground-water monitoring wells, screened 10 feet above the Bay Mud Aquitard, has been incorporated into this report. See Section 4.2, page 17, paragraph 2 and Section 5.1, page 18, last paragraph (continues to page 19).

Comment No. 3. Section 5.2, Page 19 - It is unclear as to whether the intent of this section is simply acknowledging that aquifer testing will be done, or if this section is the proposed Aquifer Testing Work Plan. As an Aquifer Testing Work Plan, it is deficient and would require more detailed information (i.e., pumping well construction and screen intervals, observation well construction and screen intervals, identification of tidal measurement locations, data recording intervals, pumping rates and justifications, modeling techniques to be used to evaluate the aquifer tests, continuous barometric recording devices, etc.) prior to approval.

Response: This section is not intended to be a work plan. The purpose of this section is to outline an aquifer testing program based on the most recent hydrogeological interpretation. The last paragraph in Section 5.2, page 23 has been added to explain this.

Figure 4. Legend - Box needs symbol added to represent the Yellow-Brown Sand. WB-2 and DA-1 boring logs need Merritt sand areas filled in with the appropriate symbol.

Response: Corrections have been made.

Figure 5. The "Fill" line between borings WB-1 and WB-4 needs to be corrected to be above the soft clay in WB-1.

Response: Corrections have been made.

Figure 7. Legend - Box needs symbol added to represent the Yellow-Brown sand.

Response: Corrections have been made.